# ASIA-PACIFIC NETWORK FOR GLOBAL CHANGE RESEARCH

## *Coastal Ecosystem and Changing Economic Activities: Challenges for Sustainability Transition along Chinese and South Asian Coasts*

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**About the project**

This project is a cross country study, financially supported by the Asia Pacific Network (APN), with a focus on inventorizing economic activities with corresponding ecosystem service flows with changing resilience level. The most vulnerable coastal system based economic activities in each country is identified through interactions with scientists, policymakers and other stakeholders. This project spans 2 years.

The objectives addressed in year-I are:

1. Identification and characterization of the coastal ecosystems

2. Identification and understanding of the traditional and new economic activities and also the actors along the coast line and changing pattern through first hand recall method, and mapping to ecosystem services.

3. Preparation of Inventory of ecological functions based economic activities

The year-II objectives can be listed as:

1. Assessment of resilience level of various economic activities given their ecosystem dependence structure.

2. Presentation of historical data on climate parameters in order to predict future scenarios for each specific study site.

3. Stakeholder behavior analysis in ecology –economy interaction framework.


The study is designed at an interface of ecology-economy interaction framework where different economic activities, though dependent on the ecosystem, impact the ecology of the ecosystem and in turn are impacted because of these changes, which are cumulated because of external environmental factors.


**Study context**

Asian countries like India, Bangladesh, China and Sri Lanka with almost 3 per cent of the global coastline are experiencing fast changes over past four /five decades. Infrastructural development in coastal areas for commercial purposes is inducing coastal habitat modification resulting in degradation of ecosystem services and posing a severe threat to biodiversity and habitat of the region. It is, therefore, important to understand threats and opportunities of sustaining the wellbeing of coastal communities in these countries, due to changing resilience with changing diversity of the ecosystem services and the additional risk associated with climate change.

**In year I**, four study sites were selected one each in Bangladesh *(Cox's Bazar Sadar-Moheshkhali)*, China *(Tianjin)*, India (*Digha-Sankarpur*) and Sri Lanka (*Koggala area),* respectively with Indian research team led by Prof .Joyashree Roy at Global Change Programme, Jadavpur University, coordinating the study.

**Study sites:**

**Bangladesh:** The study site, Cox's Bazar Sadar-Moheshkhali is located in the Cox's Bazar district of the Chittagong division, Bangladesh. The site lies between $21^0 23'16"$ to $21^0 46'26"$ N latitude and $91^0 50'34"$ to $92^0 07'50"$ E longitude and is located about 390 km from Dhaka capital city and 152 km south from Chittagong city on the east coast of the Bay of Bengal. The area is famous for natural sea beach and tourist place. A large number of people are also involved in fishing and collecting seafood and sea products for their livelihood. Major ecosystem types found in Cox's Bazar Sadar-Moheshkhali area are: mangroves, coastal mudflats, estuaries, sandy beaches, sand dunes and forests.
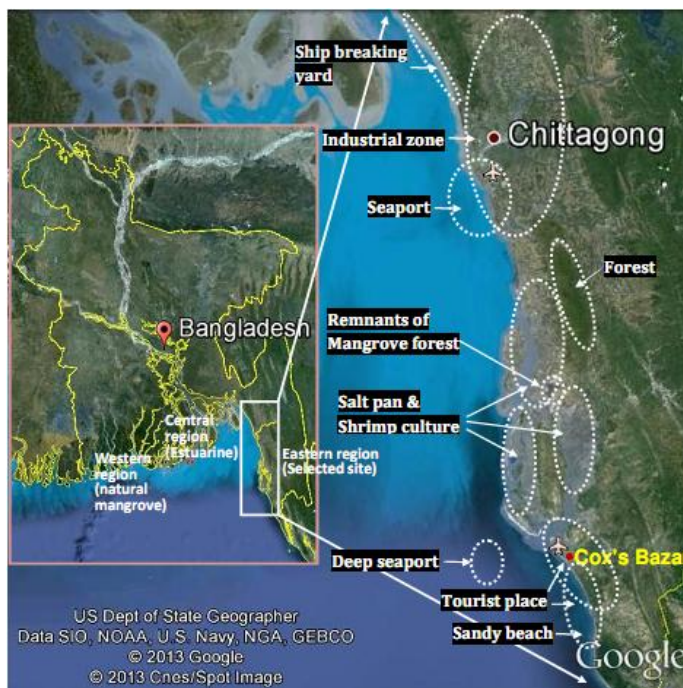


**Map 1: Chittagong and Cox's Bazaar, Bangladesh**

**China:** The field site, Tianjin in China is located in latitude 38 ° 34 'N to 40 ° 15', longitude 116 ° 43 '- 118 ° 04'E and is around 189 km long from north to south and 117 km wide from east to

west. The land area of Tianjin is about 11,919 sq. km, sea area is about 3,000 sq. km. The intertidal zone covers an area of about 336 sq. km, with a mainland coastline length of about 153.67 km and island coastline around 0.47 km. The tidal bank is 3 to 8 km long. The main marine economic activities in the study area include marine fishery, offshore oil and gas, salt-making, marine shipbuilding industry, marine biomedicine, marine transportation, coastal tourism etc.
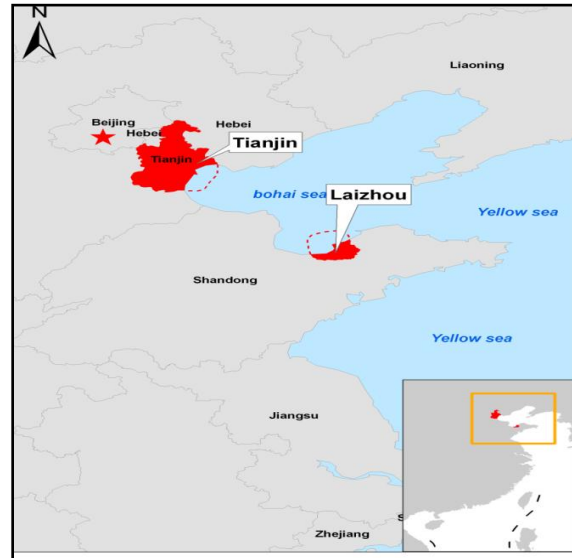


**Map 2: Tianjin, China**

**India:** Digha-Sankarpur, the study area is located in Ramnagar I and II blocks of Purba Medinipur district in West Bengal, India corresponding to the coastline from latitude 21.66° N and longitude 87.70° E to latitude 22.72° N and longitude 88.20° E. The area comprises beach areas of Dattapur, Digha, Sankarpur, Tajpur and Mandarmoni. The beach areas of Digha and adjoining Sankarpur, Tajpur and Madarmoni remain an all-time tourist destination with nearly 1 to 1.5 million tourists from West Bengal and other States visiting this area every year. A wide variety of economic activities prevail along the coast which have either direct or indirect dependence on the coastal ecosystem of Digha-Sankarpur. Fishing and agriculture are the traditional major activities along this entire coastal area. Tourism is more recent, picked up only in early seventies, and is now a major activity in Digha- Sankarpur area since 2005. Major ecosystem types found in Digha- Sankarpur area are: Sand dunes, sandy beaches and muddy beaches along with various plantations.
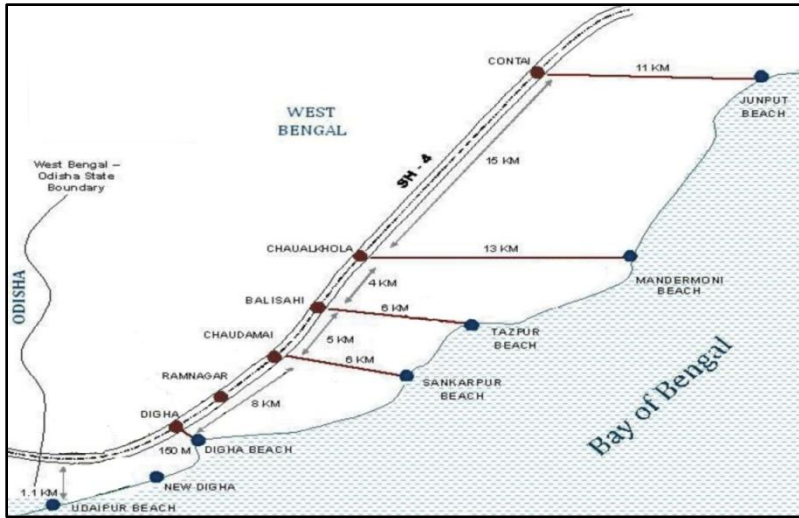
**Figure 1: Digha and adjoining areas, West Bengal, India**

Source: IL&FS (2012). Identification of Tourism Circuits across India. Interim Report prepared for the Ministry of Tourism, Government of India. Gurgaon, Haryana.

**Sri Lanka:** The study site comprises an area surrounding the Koggala Lagoon including a narrow strip of land bounded by the sea on the south and by the lagoon on the north and lying between Habaraduwa Town on the west and Ahangama on the east where the Habaraduwa DS division ends. The area to the north of the lake extends about 4 km from the shore covering mostly agricultural land. In this area, the boundary extends into the Imaduwa DS division. The west and east boundaries are close to 125 km post and 138 km post on the Galle – Matara highway, respectively. The study site lies 17 km from the district capital of Galle and 130 km from Colombo, the country's capital. Major ecosystem types in the study site are: Sandy beaches, Koggala Lagoon, Submerged reef, mangroves at Koggala Lagoon.
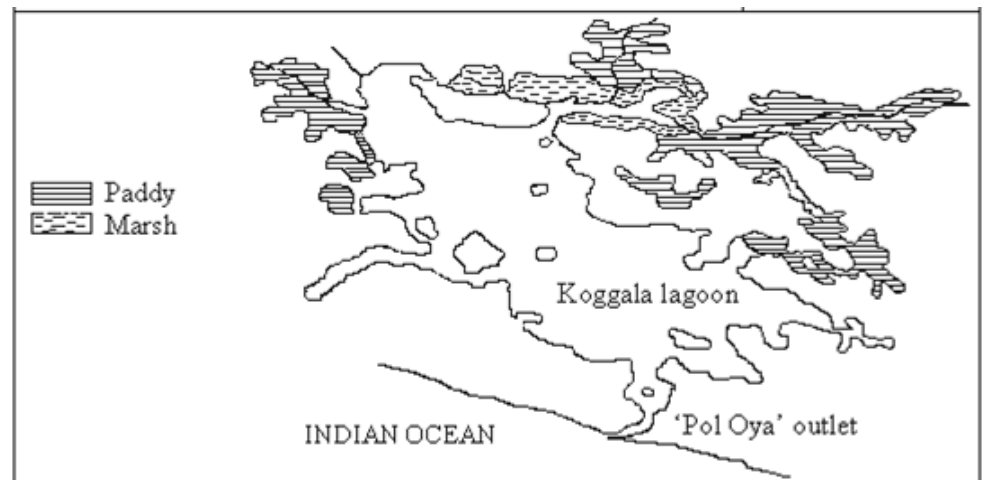


**Map3: Koggala lagoon, Sri Lanka**

**Field visits and primary data collection: Part-I**

The study draws data mainly from primary field surveys to selected study sites. Field visits in year I were mainly organized to obtain information on socio-economic and demographic characteristics of people living in these sites. The focus of these visits was mostly on identifying the changing patterns in economic activities over the years and understanding the reasons associated with these patterns. Data were sought on frequency of occurrence of natural events and hazards resulting in monetary loss to the respective individual. Separate questionnaires were drafted for major economic activities that are both directly and indirectly related to the coastal ecosystem.

**Field visits and primary data collection: Part-II**

The second year survey was carried out within the same geographical areas as the previous year's surveys. The survey focused on identifying important threats (natural and anthropogenic) to different economic activities and ecosystem types, ongoing intervention strategies available and implemented so far to reduce the impact of such threats from the perspective of different stakeholders in the three study sites (Bangladesh, India and Sri Lanka). Data were sought on different types of threats, drivers of such threats, frequency of occurrence of natural events/ hazards and human induced threats resulting in monetary loss to different stakeholders and changes in ecosystem services. Sensitivity to various threats is assessed at the level of economic activities found in the study sites in year 1. In addition to this survey a supplementary survey on the fisheries Sector in Sri Lanka was also carried out. Fisheries have been a traditional occupation of the coastal people in Sri Lanka. Fishers venturing into the sea are vulnerable to risks due to the occurrence of rough seas during stormy weather and in the recent past, there had been many casualties due to capsizing of boats. With the anticipated climate change and accompanying sea-surface temperature rise, such stormy conditions are expected to increase making fishers more vulnerable to them. One option available to reduce this risk is for fishers to venture into the sea only in large boats capable of withstanding stormy conditions.

**Secondary data**

In addition, long term trends in annual and seasonal-precipitation, maximum and minimum temperature in the study sites of India, Bangladesh and Sri Lanka at daily time scales were analyzed to arrive at current baseline climatology. Climate projections are made using PRECIS data on precipitation, maximum and minimum temperature and the CORDEX model outputs.

**Findings**

From the part-I field survey to various study sites we observed the following pattern in a shift from traditional to new economic activities:

**Shift in occupations from traditional to new economic activities in Cox's bazar-Moheshkhali, Bangladesh**

| Location | Traditional activities | New economic activities |
|---|---|---|
| Cox's Bazar Town/Sadar | Fishing, fish business, fish drying, small scale business, Agriculture | Fish drying, hotel and restaurant |
| Kolatoli | Agriculture, small scale business (grocery shop, tea stall), betel leaves trading | Shrimp fry, shop business |
| Laboni beach | Hawking, photography, | Speed boar driving, beach concert, hawking on the beach |
| Moheshkhali | Agriculture, fishing, betel leaves trading, aquaculture | Hotels and resorts, shrimp farming and salt production, fish drying |
| Sonadia Island | Agriculture, fishing, mangrove | Shrimp farming and salt production, fish drying |

**Traditional activities and new economic activities in coastal area of Tianjin, China**

| Location | Traditional activities | New economic activities |
|---|---|---|
| Coastal area in Tianjin | Mariculture<br><br>Fishing<br><br>Sightseeing<br><br>Education | Leisure vacation<br><br>Game experience<br><br>Golf<br><br>Business meeting<br><br>Disney park for children |

**Shift in occupations from traditional to new economic activities in various locations in Digha-Sankarpur, India**

| Location | Traditional activities | New economic activities |
|---|---|---|
| Dattapur | Agriculture, fishing, small-scale business (grocery shop, vegetable seller, tea stall). | Hawking on the beach and motorbike rides for tourists on beach, shell-crafting, motorized van- driving, photography on the beach. |
| New Digha | Salt-making, blacksmith, agriculture, fishing, small-scale business (grocery shop, tea stall, garment shop, manual van driving, hotels and resorts, betel leaves trading, fish business. | Hawking on the beach, hotels and resorts, manual van driving, motorized van driving, horse-rides on the beach for tourists, photography on beach, water sports, car driving, restaurants, shell-crafting. |
| Old Digha | Fishing net business, aquaculture, fishing, agriculture, hotels and resorts, manual van driving, village folk singer, fish business and small scale business (grocery shop, vegetable seller, tea stall) | Hawking on the beach, hotels and resorts, manual van driving, motorized van driving, horse-rides on the beach for tourists, photography on beach, car driving, restaurants, shell-crafting. |
| Sankarpur | Agriculture, fishing | Hotels and resorts, hawking on the beach, shell-crafting, motorbike rides on the beach for tourists, photography on the beach. |
| Tajpur | Agriculture, fishing, aquaculture | Hotels and resorts, hawking on the beach, restaurants, motorbike riding on the beach, photography on the beach. |
| Mondarmoni | Agriculture, fishing, aquaculture | Hotels and resorts, water sports, hawking on the beach, photography, motorised van driving, motor-bike rides on the beach and road for tourists. |

**Traditional and New Economic Activities in Indian Study Site**

**Shift from traditional to new economic activities in Koggala area, Sri Lanka**

| Traditional economic activities | New economic activities |
|---|---|
| Agriculture, fishing (in lagoon, stilt fishing in reefs and coastal fishing), wood-crafting | Hotel industry, industrial sector |

An important component of the vulnerability assessment, in this study, is the risk categorization of each economic activities vis-à-vis different natural threats. Under the risk assessment, four risk types are considered, these are: asset loss, Income loss, risk to lives and health risk. Our findings, which are based on the risk perception of individuals pursuing different economic activities, suggest that in an event of occurrence of any natural threat, none of the economic activities studied at Digha-Sankarpur are likely to experience any kind of risk with medium to significant intensity. Hence, vulnerability with and without risk remains the same. People engaged in beach recreation especially those providing horse-rides on the beach to tourists are marginally vulnerable followed by photographers taking pictures of tourists on the beach. After factoring in risk, it is the activities like provision of horse-rides for tourists on the beach and fishing using manual boats that are just about marginally vulnerable. Similar results are obtained from Cox's Bazar Moheshkhali study site in Bangladesh. Majority of economic activities are not associated with high levels of four risk types mentioned above, except agriculture and fishery, where coastal storms are considered as a very significant risk. Coastal storms are also considered as medium risk by salt-shrimp farming, hotel industry, fish drying and shop businesses. In an event of occurrence of any threat, none of the economic activities

are likely to experience any of the four risk types with medium to significant intensity. Hence vulnerability with and without risk remains the same. The highest relative vulnerability levels are reported by the agriculture followed by salt-shrimp farming. After factoring in risk, the overall results do not change. Finally, of the three traditional occupations considered in Koggala, Sri Lanka, the fisheries sector is likely to experience risks against all threats, whereas the agriculture and coir industry have no risks against coastal storms and coastal erosion as expected. Both the hotels and restaurants have some risk factors against coastal storms and sea water intrusion.



**Natural and Anthropogenic threats in Indian Study Site**



**Natural and Anthropogenic threats in Indian Study Site**

Finally, the Climate change projections (IPCC AR4 Projections, PRECIS A1B Scenario and IPCC AR5 Projections, SMHI RCP4.5 Scenario) for the study sites indicate that the increase in minimum temperature is likely to impact the recreational and provisioning services in both Sri Lanka and India, while mainly provisioning services in Bangladesh. The main economic activities

impacted in each study site because of the increase in minimum temperature are: fishing, agriculture and tourism in Sri Lanka, fishing, aquaculture and tourism in India while fishing and agriculture in Bangladesh. As per the IPCC AR4 rainfall projections, PRECIS A1B Scenario and the IPCC AR5 Projections, SMHI RCP4.5 scenario for the study sites, provisioning and regulating services in all the study sites will be adversely impacted. In addition, regulatory services will be severely impacted in India. The most vulnerable activities identified in the study sites as a result of mean annual rainfall changes are: fishing, tourism and aquaculture in India, fishing, agriculture and tourism in Sri Lanka and finally, fishing, agriculture and aquaculture in Bangladesh.

## Conclusions

The main highlight of this project is extensive consultation with policy makers and stakeholders in all the three countries. The various field studies have helped in advancing our understanding of the current economic actor specific approach to risk assessment for coastal community given that every economic actor is trying to maximize benefit from the livelihood option chosen while the conceptual framework suggests taking an ecosystem based approach may yield a different outcome. Using these two approaches, we have tried to understand and compare the results.

Finally, we conclude by identifying from each country the different local coastal ecosystem types, ecosystem services that communities have used the most and likely impacts of both natural and anthropogenic threats. The results are area specific so no attempt has been made to generalize.

## Reports and Publications:

Over a period of two years, three project reports were prepared and submitted to APN including the final report sent in June 2015.

## Newsletter

Roy,Joyashree; Kapuria, Preeti; Datta, Satabdi; Guha, Indrila; Banerji, Rajarshi; Rao, Sandhya; Miah, Giasuddin; Chen, Shang; Li, Jingmei ; Xia, Tao; Ratnasiri, Janaka ; P.B. Terney Pradeep Kumara; Lokuhetti, Chinthaka S. "Coastal Ecosystems and Changing Economic Activities: Challanges for Sustainability Transition along Chinese and South Asian Coasts." APN Science Bulletin (Asia Pacific Network for Global Change Research) March 2013, no. 3 (2013).

**Activities**

An Inception Workshop was held on 7th-9th January, 2013 in Kolkata, India . The workshop was meant for participation and discussion on: ecosystem services in ecological economics framework, firming up of research questions, hypothesis and methodology for analysis and work time line with deliverables. Participants felt collaboratively we achieved workshop goals and all felt that the workshop helped in getting closer to shared understanding of key concepts.



**Inception workshop (7th-9th January, 2013), Kolkata, India**

A three day workshop was held in Koggala, Sri Lanka from 8-10th January 2015 to discuss work progress and final report format for a timely submission. Team members from all the three countries participated.  The members were of the opinion that the proposed collaborative project has been successful in achieving its goals; same questionnaire was used by all the three collaborating countries, concept note was circulated among the collaborators  for comments and suggestions and micro-level information from the field has been applied to India, Sri Lanka and Bangladesh.

**Sri Lanka Workshop (8- 10<sup>th</sup> January 2015), Koggala, Sri Lanka**



**Sri Lanka Workshop field visit (8-10<sup>th</sup> January 2015), Koggala, Sri Lanka**